A GUIDE TO THE ASPIRING ASTRONOMER

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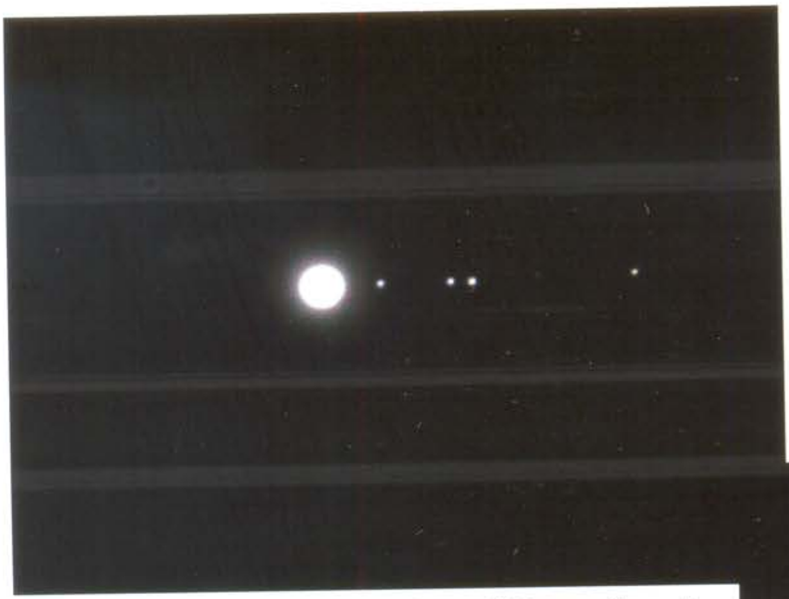
Introduction

It does you no good to have a new telescope and a bunch of star atlases if you cannot find your way around the sky. My suggestion is this: put away your telescope at first and just learn the sky. Start with the Taramandal. It is a nice tool to learn the standard patterns you can mentally form with the stars in the sky. These patterns, called constellations, provide you a road map for your search-ways during any astronomical quest. But you can easily imagine that the real sky is much vaster and it is populated with more numerous stars. So, there is nothing like training with the real sky. The fine point is, if you are comfortable with the Taramandal, you not only stand a better chance of finding your way through the real sky, you can also act as your own teacher when it comes to trying out more serious astronomy lessons.

If the temptation to use your equipment is too great, take your telescope out when the Moon is bright. Gaze at the Moon or at the easy-to-find planets like Venus, Jupiter, and Saturn. Then put away your telescope for some time and continue with this first lesson.

A Celestron 14" Schmidt-Cassegrain Telescope can be a real good companion for life.



It is not by chance that Jupiter is frequently nicknamed the "planet of the amateurs"... Its magnitude (ranging from -1.3 to -2.7), its large apparent diameter (about 30 to 60 arcsec during conjunction and opposition, respectively), its long visibility period (about 360 days in each one of the apparitions that last for 398 days), its fast-rotating disk full of dynamic colored features, and its cohort of bright satellites, make it an irresistible target.

The maximum angular separation of Venus from the Sun is 47 degrees, but when the planet is well placed, e.g. when greatest elongation east occurs near the vernal equinox, the planet may be visible for more than four hours after sunset. A similarly favourable presentation in the morning sky occurs when Venus comes to greatest elongation west near the autumnal equinox. Conversely, when greatest elongation east occurs near the autumnal equinox the ecliptic makes a shallow gradient to the horizon and Venus is poorly seen in the evening sky; when greatest elongation west occurs near the vernal equinox the ecliptic makes a shallow gradient to the horizon and Venus is poorly seen in the morning sky.

Christian Huygens had made probably the first informative sketch of Mars. The best time to observe this planet is when it's closest to Earth (about every two years). When you first look at this object with your scope you will most likely see a blob. Keep practicing; eventually you will have trained your eyes to see fainter details. As it never will appear as large as Jupiter, you will need to use higher magnifications if you want to see a lot of detail. Like all objects, try to observe this one as high in the sky as you can. You may be able to eventually see the Polar caps, dark areas, dust storms, and even small clouds. Filters are often recommended for this planet as well.

Lesson One

Learn the Sky

The first and most important step in learning the sky is to study the constellations. A good knowledge of the constellations is essential in order to learn how to star-hop from object to object, an art that will be explained in a later lesson.

Purchase a simple star book that has constellation charts. The Usborne Spotter's Guide, 'The Night Sky' can be a good place to begin with. *Sky & Telescope* magazine available on newsstand, publish monthly star charts. But, my personal favourite is *Sky watching* by David Levy. Alas! This book is out of print for many days.

This publication is a set of five lessons designed to assist those who are just starting out in astronomy. These lessons might be equally instructive to those who have been trying for a few years to use their own telescopes but have had trouble finding objects that should be easy to locate. Though full of desire and enthusiasm for stargazing, they may have just gotten off on the wrong foot.

Collect even an old copy if you get one. The only instruments you will need besides your eyes will be a pair of binoculars and a flashlight with a red lens. Just about any pair of binoculars you have will do for now. Before you purchase new binoculars that you expect to use in the future for more advanced stargazing, ask an experienced astronomer for buying tips.

You might have difficulty picking out the constellation stars from the rest in a rich, star filled sky. So begin at a site that is not pitch black. After you learn the constellations it is the time to go to the darker sites away from the city.

Go at your own pace. At first, study one or two new constellations a night, using your constellation chart book as a guide. Learn their stars well and take the time with your binoculars to enjoy the general sky within each constellation. Your naked eye will be sufficient to find and learn some of the bright constellations such as Orion, Ursa Major, and Cassiopeia.

You will need binoculars to see the dim ones such as Lacerta, Camelopardalis, and Cancer. Finally, you will use both the naked eye and binoculars to see constellations containing both bright and dim stars.

Don't expect to learn all the constellations at once. Many constellations are visible at night only during a particular season. Plan on taking nearly a year to learn all the ones visible in the northern hemisphere. Some constellations in the southern hemisphere, of course, are not viewable here at any time.

Lesson Two

Learn the Movements of the Constellations

As you watch the same constellations over a period of months, you will complete the second step in learning the sky: learning the paths that different constellations take across the sky. These patterns will help you learn which constellations are visible during different times of the year and how long they are visible for.

The constellations near the North Star are visible all year long. They are called circumpolar constellations. However, when such constellations are below the North Star (due north and near the horizon), they are more difficult to see. It is better to view them when they are east, south ("above"), or west of the North Star. Examples of circumpolar constellations are Ursa Minor and Cepheus*.

Another group of constellations rise generally in the east, travel across the sky to a point near the zenith or directly overhead, and set generally in the west. They are best viewed when they are up high in the sky, between forty-five degrees above the eastern horizon and forty-five degrees above the western horizon. These constellations are visible during normal nighttime viewing for approximately half of the year. Among this large group of constellations are Hercules, Cygnus, and Leo.

Finally, there are other constellations that rise between the southeast and south and set between the south and southwest. They may be viewable only two to four months out of the year. Because they are always low in the sky, they are often harder to see. You may need to find an observing location that does not have city lights to the south to view these constellations effectively. Included in this group are Scorpius, Cetus, and Hydra. You will soon learn other patterns. All the constellations are in our galaxy; however, those found along the galactic plane are considered to be in the "Milky Way." You will quickly see that these are much denser with stars than the rest of the constellations. You will also learn the twelve constellations of the Zodiac. They, too, are found in the plane of our solar system, where you can also find the Sun, the Moon, and the planets.

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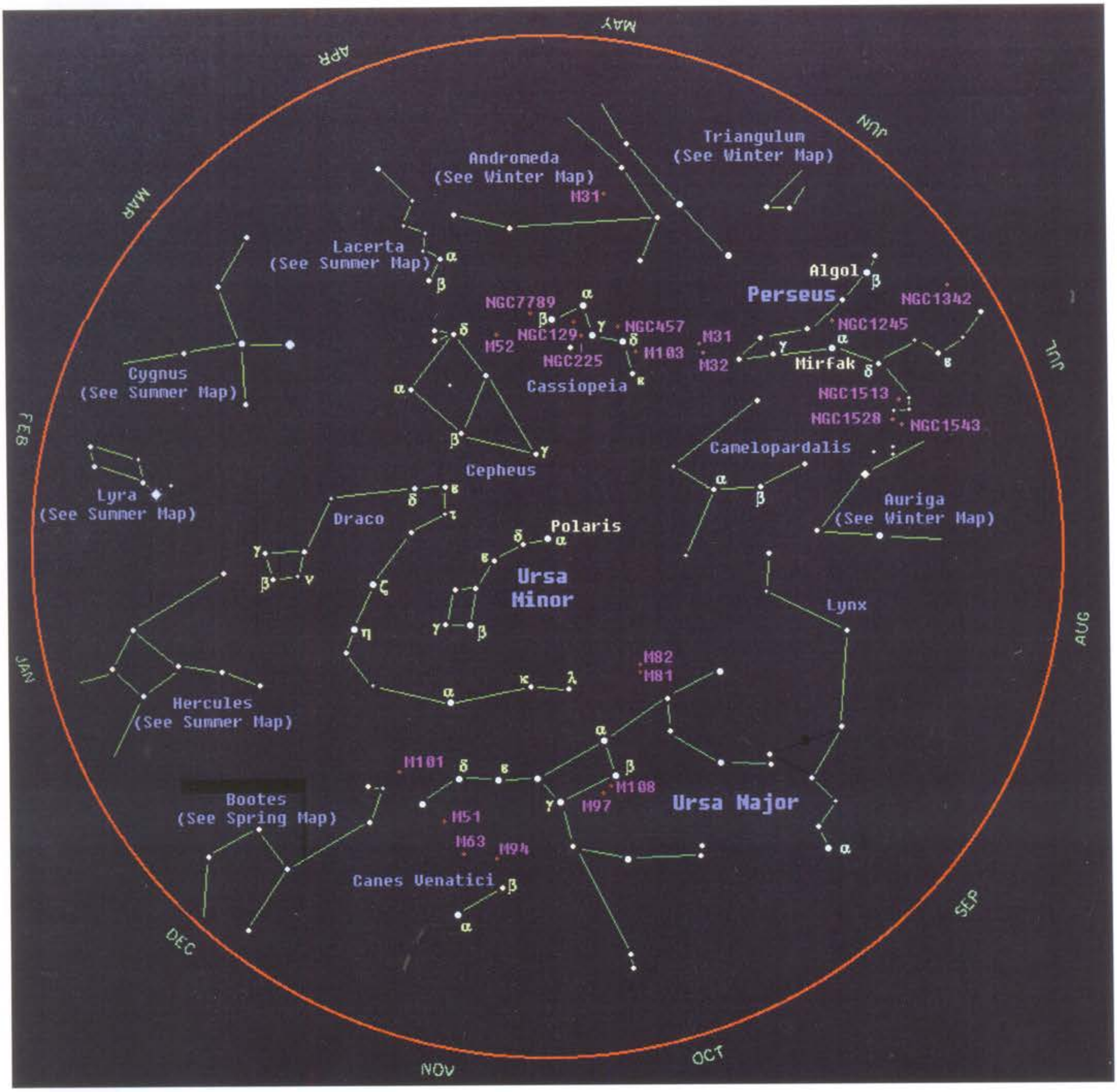
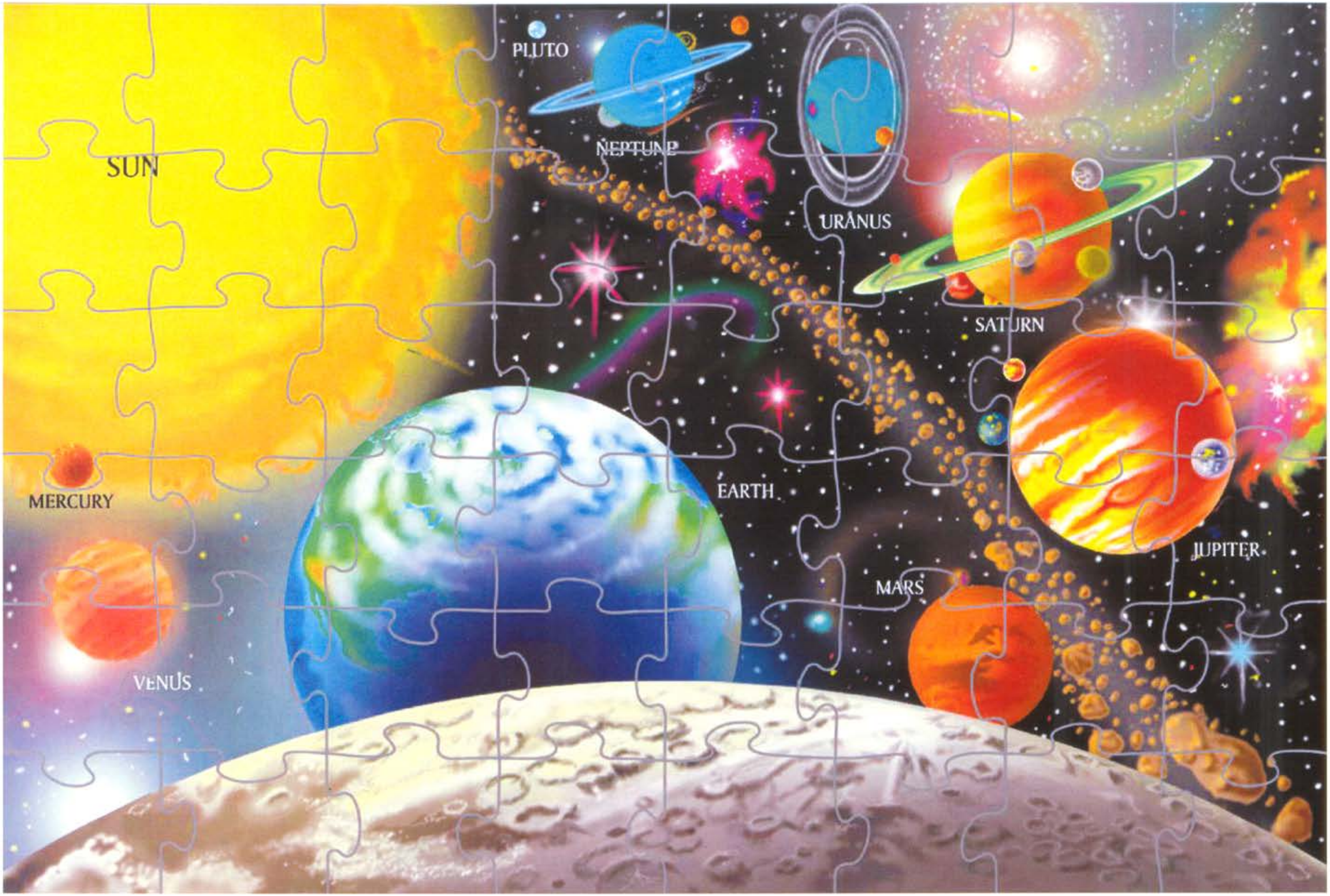
*Cassiopeia and Ursa Major appears to be circumpolar constellations at higher latitudes



These are the stars of the north circumpolar region. At the North Pole, these stars are circling overhead all night. Around 40 degrees north latitude they are in the north sky, most of them visible all night. South of the equator these stars are never visible.



Copy this image on a cardboard and you get a Solar Syatem Puzzle.

Keep a Star Log

You should keep a journal or star log beginning with the first time you gaze at the stars. Such a log will record your progress. In future years, you will be able to look back with satisfaction at what you have accomplished. It will also remind you to take a second or third look at objects you viewed in the past and found particularly noteworthy. Your journal will tell you when the best time would be to view these objects.

Your logbook doesn't have to be anything fancy. It may be as simple as a spiral notebook. It is so helping you would love to use it even when you turn out to be a veteran astronomy observer. We suggest you create a monthly calendar on the left-hand pages. You can make the calendars a month or two in advance. List the dates of the phases of the Moon and the dates of any special events such as eclipses or occultations. You might consider subscribing to *Sky & Telescope* magazine. It contains such calendar information. The *Free downloadable* software *'Starcalc'* can generate star charts and can point out locations of Astronomical objects. The Inter University Consortium for Astronomy and Astrophysics (IUCAA) publishes a quarterly bulletin *'Khagol'* that is rich in astronomical information.

Subscribe to Sky & Telescope *magazine. It has regular monthly star charts, plus a calendar of what to view each month. The main publishing address is:*

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Download the package Starcalc from http://www.relex.ru/~zalex/files_eng.htm The site has additional plug-ins for the Starcalc package that permits you to locate deep-space objects, solar and lunar eclipses and comets. It has a user-friendly interface and a convenient learning curve.

Put on your calendar page a list of constellations or other objects you intend to study or view that month. You can then use the right-hand pages to record your observations. Your entry can be as simple or as detailed as you choose. You should at least record the date, time, and place of viewing; the sky conditions; and a brief description of what you viewed. You may also want to include a simple sketch from time to time. At first you will be mainly listing the constellations you have studied and viewed. You may also want to keep, on a separate page, a running list of constellations as you learn them. Before long you will be starting lists of other objects as well. You'll be well on your way to learning the sky. At the same time you will also come to know the common names of some of the brighter stars within those constellations. Knowing them will also help you learn how to star-hop. And soon you will be ready for Lesson Three.

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Lesson Three

Train Your Telescope on Objects in the Solar System

You can learn to use your telescope by practicing on the Moon and the planets of our solar system. Planets will be the brightest objects in the area of the sky in which they can be found. Over a period of time, they will move from constellation to constellation. Once you have an object centered in any finderscope, look at it through the eyepiece.

These objects will take high power — the lower the number designation of the eyepiece, the higher the power or magnification. Practice moving the telescope while looking in the eyepiece to learn your directions. Here is a guide to the lunar and planetary observations in 2005.

The moon is easy to view in first telescopes. Get a lunar atlas and learn the names of the craters. Lunar features are most easily visible along the terminator, the line dividing night from day.

The Moon: Use a low power eyepiece at first that will show the entire Moon. After centering a particular area you want to view, you can change to one with higher power. Start with a Full Moon. The darker areas are called mare or "seas." The lighter areas are higher land formations including mountain ranges. Craters can be seen in both. Ejecta rays can be seen extending from certain craters. The most prominent rays extend from the crater Tycho. They should be easy to find. As the Moon goes through its phases, a shadow travels across the lunar surface. The line where the illuminated area and the shadow meet is called "the terminator." Looking at it in your scope will provide many spectacular sights, particularly on mountain peaks and in craters. Near the terminator you may see the sunlight hitting a peak in a crater's shadow to form a bright dot. Other times you can see a bright streak across a dark crater surface as the sunlight passes through a break in the crater rim. Soon you will become aware of what you can see best during each lunar phase. You may want to get a lunar map to assist in your exploring.

Like Earth, moon is always half illuminated by the sun. In other words, the round globe of the moon has a "day side" and a "night side." From our earthly vantage point, as the moon orbits around Earth, we see varying fractions of its day and night sides. These are the changing phases of the moon.

The moon's orbital motion can be detected in front of the stars from one night to the next. It's as though the moon is moving on the inside of a circle of 360 degrees. Thus the moon moves about 12 degrees each day. The moon's orbital motion is toward the east. Each day, as the moon moves another 12 degrees toward the east on the sky's dome, Earth has to rotate a little longer to bring you around to where the moon is in space. Thus the moon rises, on average, about 50 minutes later each day.

Mercury: You will always locate Mercury above a flat, unobstructed horizon within an hour or so before sunrise or after sunset, depending on where the planet is in its orbit. This planet has three evening appearances and three morning appearances each year, but not all of these are favorable for viewing. The best time of year to locate Mercury in the evening is springtime, when the angle of the ecliptic—or path of the sun, moon and planets—is inclined almost perpendicularly to the horizon. When days are lengthening and the world at your feet seems born anew, you will often find Mercury shining gaily in the western sky, above the place where the sun set. Meanwhile, the best predawn appearances of Mercury always come in the autumn.

Some people think that Mercury is the faintest planet, but that's not so. To the eye, this innermost world looks like a bright star. Within a few days of passing between Earth and the sun, Mercury does something fascinating for telescope users. It takes on the appearance of a tiny crescent through any telescope working at modest magnification.

Venus: Like Mercury, Venus swings between morning and evening skies visible from Earth. Its location in our sky depends on where it is in its 244-day orbit around the sun. But because Venus orbits farther from the sun than Mercury, opportunities to see it stretch out for months rather than, as is Mercury's case, days at a time. Venus can appear farther from the sun in our sky than Mercury, 48 degrees in contrast to Mercury's 28 degrees. Venus appears in the evening sky about six weeks after it has passed most directly behind the sun as seen from Earth. It starts low in the sky, but, evening by evening, grows brighter as it climbs higher in the west after sunset. At its highest above the sunset point, Venus is about halfway between the horizons and overhead. It is a lovely, conspicuous evening "star" that sets more than three hours after the sun.

After reaching its greatest height in the sky, the sun seems to reel Venus in, and the planet appears lower each day in the evening twilight sky. Because it is really coming near to us, during this time Venus is getting brighter. There is always a day of "greatest brilliancy" near the end of each evening apparition. Then reports of UFOs always increase as Venus looms eerily bright, low in the evening sky! Around this time, the view through a telescope reveals a waning crescent phase for Venus.

All too soon, Venus disappears into the sun's glare as it passes between the Earth and sun—only to become visible again a week or two later as a brilliant light low in the eastern, predawn sky. There is another time of greatest brilliancy and then, as in the evening, Venus climbs away from the sun's glare before dawn. About eight weeks after its reappearance before dawn, Venus reaches its greatest height in the eastern sky, at which time the planet rises more than three hours before the sun. Then Venus begins to sink toward the sun's glare again, slowly, as the planet flees far ahead of Earth in orbit. After more than nine months as a morning "star," Venus once again disappears from view for earthly stargazers, this time because the planet is so far ahead of us in orbit that the sun comes between us and it. There is a period of several months in which we cannot see Venus. Then one fair evening you will spot her low in the west again—surprisingly bright for being so low in the sky!

Mars: It takes Mars about twice as long to orbit the Sun as the Earth does. Therefore it will be prominent in the sky every two years for about six months. The most prominent feature you might see is one of its polar ice caps. During those years when Mars is closest to us you should be able to see some of its other larger surface markings.

Mars' orbit around the sun takes only two years, in contrast to our single year. Thus Mars follows about a two-year cycle of observability in our sky. The cycle begins when we first glimpse Mars on the opposite side of the solar system, perhaps 19 light-minutes away. At this time, Mars appears in our predawn sky—low in the east, near the sun's glare—very faint and remote. Bright stars in their constellations rise earlier from one day to the next, and thus the stars sweep up in the east behind Mars. But Mars itself is destined to loom near the early morning twilight for many months. During this time, Earth's faster motion in orbit—and smaller orbit around the sun—cause the distance between us and Mars to decrease. Thus Mars slowly gets brighter. Then there always comes a time when we suddenly seem hot on the heels of Mars in the race of the planets around the sun. Suddenly Mars is rising noticeably earlier each day. Before you know it, the planet can be seen rising at midnight, then at 10 p.m. All the while, Mars is getting much brighter—and brighter still. Soon it's as bright as the sky's brightest stars.

Jupiter: Jupiter takes twelve years to revolve around the sun. Therefore it can be seen in a different zodiacal constellation each year. Jupiter's four largest moons — Io, Europa, Callisto and Ganymede — are the planet's viewing highlights. Because their orbital planes are perpendicular to Earth's orbit, they appear as bright dots along a line. You can watch them move with respect to each other and Jupiter, hour by hour. At times, one or more of them may be unobservable while passing behind or in front of the planet. Other times they may become fainter or go dark altogether while being eclipsed by Jupiter. On the planet itself the equatorial zones can be seen as parallel lines. You may be lucky and occasionally see the Great Red Spot.

We see Jupiter for much of every year. We do not see it only when the sun is between us and it. The planet emerges from the sun's glare in the east before dawn—much as Mars does—but because Jupiter moves more slowly with respect to the stars, it follows the stars' motion up and away from the dawn. It shifts into the midnight sky, and then the late evening sky, and then—like Mars—comes to opposition when it is rising in the east as the sun sets in the west, as we fly between Jupiter and the sun. But the opposition of Jupiter is yearly instead of every two years. What's more, although Jupiter is indeed brighter at opposition, this planet is always so amazingly bright that the contrast in various parts of its orbit is not so great as that of Mars. Whenever it's visible, Jupiter is a bold starlike object in our sky, brighter than any star—but not so bright as Venus!

Saturn: Saturn can be seen in a different constellation every two years. It is visible during the time the constellation is observable. Saturn's ring system, when seen face on, is probably the most spectacular sight in the solar system. However, the ring plane becomes oriented vertically to us every 15 years. When it is thus viewed edge on, it can't be seen from Earth at all for a short time. Such was the case in 1996. Shortly after that the rings appeared as one bright line. As the ring plane opened up you could see larger portions of the rings. In a small telescope, the rings appeared as one big ring. Other observable highlights are the ring shadow on the surfaces of Saturn and Titan, the planet's largest moon.

The last planet in our solar system known since antiquity—the last one visible to the eye alone—lies beyond Jupiter. Saturn is probably the solar system's most showcased object for telescopic observers. To the unaided eye and through binoculars, however, it looks nothing more than a bright, butterscotch-hued star.

Saturn is the faintest of the bright planets, and it moves most slowly of these planets among the stars, taking 30 years to orbit the sun once and thus 30 years to complete a single circuit around our sky. That is why some early stargazers called Saturn a name that means "oldest of the old sheep."

Saturn follows, more or less, the same pattern as Jupiter from one year to the next. We see it in the eastern, predawn sky—then at midnight—then in late evening—then rising in the east at sunset as the planet comes to its yearly opposition. Like Jupiter, Saturn is brightest to the eye at opposition, but the contrast in its brightness from one part of the year to the next is not great. Indeed, this world's appeal lies not in its changeability and not in any dramatic movement of Saturn in front of the stars. The appeal of Saturn is in the gentle quality of its bright golden light, and in the fact that this planet returns reliably, year after year, to nearly the same part of the sky. If you begin watching Saturn in the evening in autumn one year, you can be sure that Saturn will grace your evening sky at nearly that same season the following year. It does shift with respect to the stars, as all the planets do, but it does so with an impressive slowness.

The view through a telescope at Saturn is nothing short of spectacular. Even a small telescope will reveal the planet's ring system composed of rock and ice particles that never formed a moon. A telescope may also reveal reddish Titan, a smog-enshrouded moon that takes almost 16 days to complete a circuit of its home planet.

Uranus, Neptune and Pluto: Our solar system's three remaining planets were discovered relatively recently. Uranus, which at its brightest is barely visible as a greenish "star," was discovered during a telescopic search in 1781. This planet takes 84 years—about the length of a human lifespan—to orbit the sun once. Backyard observers routinely spot Uranus through a pair of binoculars, provided they have a current finder chart.

Computational mathematics pulled Neptune in from the cold in 1846. This planet is a thousand million miles farther from the sun than Uranus. It requires 165 years to orbit the sun once. Neptune usually looks like a nondescript star through the eyepiece of a small telescope. Some people say its color is bluish. The challenge is spotting it among background stars, which is where a good finder map is necessary.

Faint Pluto was found in 1930 after an exhaustive photographic search. This planet orbits the sun once every 248 years. Only observers armed with telescopes that have mirrors at least ten inches in diameter go for this faint target under dark skies.

Observing Meteor Showers: To get the maximum results in observing any meteor shower, you need to know four things. First, you need to know the day and time of the shower's peak. The "peak" is just what it implies. It's a point in time when Earth encounters the greatest number of meteoric particles in a particular stream. If you miss the peak, or if it occurs when it's daylight in your part of the world, you won't see as many meteors. But don't let that discourage you. Predictions of the peak are not always right on the money. And it's possible to see very nice meteor displays hours before or after the true peak.

If you're interested in learning about meteor showers, or want to contribute meteor counts and brightness estimations, contact the following organizations: The American Meteor Society, at http://www.amsmeteors.org/ and the International Meteor Organization at http://www.imo.net/. Both provide the latest predictions as well as information to guide you in serious meteor observing.

Not every meteor shower is a winner. Sometimes, you may come away from a shower seeing only one, but if it's a good one, it's worth it. To be really successful at observing any meteor shower, you need to get into a kind of Zen state, waiting and expecting the meteors to come to you if you place yourself in the position to see them. Very often, you will. Of course, if the Eastern philosophical approach doesn't impress you then be guided by the old meteor watcher's motto, which says, you may see a lot, you may see many, but if you stay in the house, you won't see any.

Lesson Four

Learn to Starhop

The easier it is to find deep sky objects, the more fun you'll have with amateur astronomy. You won't need setting circles or computers. All you'll need is your telescope, a finderscope, and a low power eyepiece. Add some star maps and you're ready to go.

The art of starhopping requires you to locate a naked-eye star near your target deep sky object. Put the star in the center of your finderscope. Then use one of the techniques explained below to locate your object. Any fair finderscope will work.

We describe five starhopping techniques using different Messier objects as targets. You should use the lowest power eyepiece with the widest field of view that you have, to make it easier to locate objects. You can then switch to higher power as needed. Refer to your favorite star chart to find the general location of these objects.

1. In Line With Two Stars: The simplest technique is to "hop" from one star to another to your object. M31, the Andromeda Galaxy, can be quickly found using this technique. Aim your finder at the bright star Beta Andromedae. Then move your finder to another naked-eye star above it, Mu Andromedae. Continue to move your finder in the same direction, to a distance same as the distance between the two bright stars. Now look in your eyepiece and you should see this great galaxy.

2. Between Two Stars: The small globular cluster M80 in Scorpius can be elusive but you should have no difficulty if you use this technique. Locate the two brightest stars in Scorpius: Antares (Alpha) and Beta. Aim your finder exactly halfway down an imaginary line between the two. M80 should be right there. Vary this technique. Look at star atlases to see which objects lie on a straight line between two bright stars. Aim your scope the appropriate distance between the two, whether that distance 1/2 or 2/3 is or some other fraction that is easily approximated.

3. In a Triangle with Two Stars: While still in Scorpius, you can learn another technique by locating the large globular cluster M4. It forms an isosceles triangle with Antares (Alpha) and Sigma. Aim your finder 1 degree below the center of a line between Alpha and Sigma, the longest leg, and at a right angle to it. Aim the finderscope so that the 2-degree circle touches the halfway point between the two stars. M4 should be in your view.

You can find many other patterns of triangles between two naked-eye stars and a deep sky object. For example, the galaxy M94 is approximately 2 degrees above and at right angle to the halfway point between the stars Cor Caroli (Alpha) and Beta, in Canes Venatici.

4. At the Intersection of Two Lines of Stars: Some deep sky objects are not close enough to a naked-eye star to use any of these techniques. However, they usually fall along lines between several pairs of stars that are farther away. Aim your finder where these lines intersect to find your object.

For example, M3 is on an imaginary line between Arcturus and Cor Caroli. It is also on a line that connects Epsilon Bootis and Beta Comae (Berenices). Point your scope to where these lines intersect. With a low power eyepiece, you should be able to see the bright cluster almost in the center of your view.

5. In The Eyepiece: To locate fainter objects, you will need to learn how to starhop through your eyepiece. Find a nearby bright star and aim your finder at it. Starting with your eye on the eyepiece with the bright star in the center, move the scope while following stars or star patterns to get to your target object.

To find the galaxy M108, aim your finder at Beta Ursa Majoris, the lowest star to the right in the bottom of the Dipper's bowl. You will notice two fainter stars near Beta in the eyepiece. Starting with the one nearest Beta, move your scope to Beta; keep going in the same direction about 2/3 of a degree to a brighter star. Continue on this line, passing two more faint stars, which are an equal distance apart. Follow the last star to another star close to it at a 135-degree angle. On that line, the same distance away as these last two stars are from each other, is M108. Making a right angle to the south, you will find a bright star 1-degree away. Within the eyepiece will be M97, the Owl Nebula.

As you become more experienced, get out your star atlas and pick objects to find. Look at the brighter stars or star patterns nearby and determine which technique to use for each object. Then have fun finding them. Following it, you are considered expert and are encouraged to develop your own techniques.

Lesson Five

Planning an Observing Session

There are two rules in planning an observing session: make it simple and make it fun. In other words, your planning should help you spend the night enjoying objects rather than struggling to find them.

Deciding What to View

To decide which objects to view, use your computer and the Starcalc package to check out which constellations will be observable that night. As a beginner, you may not feel confident to decide which objects to view. We suggest getting a beginner's book that does the planning for you.

Alan MacRobert's *Star-hopping for Backyard Astronomers* (Paperback edition is available now) is an excellent choice. He picks different areas of the sky and chooses ten or twelve objects in each section that are close together and within the range of the beginner. His sky charts and descriptions of the objects lead you through the session.

Deep-sky objects fall into five categories: galaxies, nebulae, planetary nebulae, globular clusters, and open clusters. Favorite telescope targets include M4, globluar cluster in Scorpius, and M31, the Great Galaxy in Andromeda.

Another method is to pick a constellation and view the deep sky objects within it. We found the most useful book for this method is *Observing the Constellations* by Sanford. This book includes a chart of each constellation along with locations of the objects, a list of each prominent object with parameters such as size and magnitude, and a description of the best ones to view. Another book that is similar is the *Skywatching* by David Lavy. A common way to choose objects is to use the famous Messier list. All the books we've mentioned include the Messier objects. Just pick which ones you'd like to locate each night.

Finally, as you gain experience you may want to obtain the 3-volume Burnham's *Celestial Handbook*. While it doesn't contain star maps, it provides a tremendous amount of information on many objects and will help you choose targets for later observing sessions.

Documenting Your Viewing Session

As always, you'll want to document your observations. Some objects are verifiable merely by looking at them. However, many of these objects are dim; so you can't always be sure you are looking at what you planned to. Always draw the object and the stars you see with it in the eyepiece. A folded piece of paper or a note card works fine.

Your drawings need not be exact; just show the object in relation to the stars nearby. When you get home, you can compare the rough drawing to the photographs or star charts in the books you have. If you have access to the Internet, try using the Digitized Sky Survey <*http://stdatu.stsci.edu/dss/*>. It contains photographs of the entire sky with all the deep-sky objects and the stars around them. The stars seen in most amateur telescopes appear bright and slightly spiked in DSS, making for easy comparison with your drawing. Finally, memorialize your observing session with notes and descriptions in your star journal, as simply or as detailed as you want.

You may wonder when you'll have the time to look through the books, choose objects to view, and make your field charts. Remember all those cold winter nights or the many cloudy nights the rest of the year. That's when you plan for the few nights of good seeing to come.

Calendar Year 2005

2005, for afficionados, is a Martian campaign year. Mars came at its opposition, that is at the nearest to the Earth. And this year, like in 2003, this opposition is perihelic. Earth is at its nearest to the Sun as it is at its nearest to Earth at the same time, making that Mars reached an important 20.2" of apparent diameter. For more casual observers, it's a good opportunity to begin to look at Mars. On the other hand 2005 will grant the observers with a hybrid eclipse in April (visible as annular in Panama and Columbia), an annular eclipse in October (Africa) as Moon will be occulted by penumbra only in April and occulted only partially in October. Venus in 2005 will be a fine evening star starting before mid-year. Jupiter will be about Spica of the Virgin all yearlong as Saturn will remarkably hover about cluster M44 – the Beehive, since September. As far as space is concerned, Japanese Hayabusa craft is to arrive at its target-asteroid during summer as a new NASA orbiter for Mars will be launched in August. Cassini is continuing its 4-year tour of the Saturn's system as by year's beginning, on January 14th, the ESA Huygens probe it is carrying has descended into Titan's atmosphere.

Calendar Year 2006

The following list contains dates for notable celestial events including moon phases, meteor showers, eclipses, occultations, oppositions, conjunctions, and other interesting events. Most of these events can be seen with unaided eye although some may require a good pair of binoculars for best viewing. Many of these events and dates were obtained from the U.S. Naval Observatory and the NASA/Goddard Space Flight Center. Events are organized by date and each is identified with an icon as outlined below:

- Full Moon
- New Moon
- Lunar Eclipse
- Solar Eclipse
- Solar Event
- Planetary Event
- Occultation
- Conjunction
- Meteor Shower
- Comet

January 3 - Quadrantids Meteor Shower. The Quadrantids are an above average shower, with up to 40 meteors per hours at their peak. The shower will peak this year on January 3, but some meteors will be visible from December 28 - January 7. Best viewing will be from a dark location after midnight on the morning of the 4th. Look to the northeast. The crescent moon will set early ensuring a dark sky for an optimal performance!

January 14 - Full Moon

January 27 - Saturn at Opposition. The ringed planet will be at its closest approach to Earth. This is the best time to view and photograph Saturn and its moons.

January 29 - New Moon

February 13 - Full Moon

February 28 - New Moon

March 14 - Full Moon

March 14 - Penumbral Lunar Eclipse. The eclipse will be visible throughout most of the Americas, Europe, Africa, and Asia. (NASA)

March 20 - The Vernal Equinox Eclipse Information occurs in the northern hemisphere at 18:26 UT. There will be equal amounts of day and night. This is also the first day of spring.

March 29 - New Moon

March 29 - Total Solar Eclipse. The path of totality will begin in the Atlantic Ocean off the coast of Brazil and move east through central Africa, Turkey, and central Asia where it will end in central Russia. A partial eclipse will be visible throughout most of Africa, Europe, and Western Asia.

April 13 - Full Moon

April 22 - Lyrids Meteor Shower. The Lyrids are an average shower, usually producing about 20 meteors per hour at their peak. The shower will peak this year on April 22, although some meteors will be visible from April 16 - 25. The near-quarter moon will hide many of the faint meteors this year. Look for meteors radiating from the constellation of Lyra after midnight.

April 27 - New Moon

May 4 - Jupiter at Opposition. The giant planet will be at its closest approach to Earth. This is the best time to view and photograph Jupiter and its moons.

May 5 - Eta Aquarids Meteor Shower. The Eta Aquarids are a light shower, usually producing about 10 meteors per hour at their peak. The shower will peak this year on May 5, however some meteors can be seen from April 21 - May 12. Viewing should be good this year with the first quarter moon setting shortly after midnight.The radiant point for this shower will be in the constellation of Aquarius. Best viewing is usually to the east after midnight.

May 13 - Full Moon

May 27 - New Moon

June 11 - Full Moon

June 21 - The Summer Solstice occurs in the northern hemisphere at 12:26 UT. The Sun is at its highest point in the sky and it will be the longest day of the year. This is also the first day of summer.

June 25 - New Moon

July 11 - Full Moon

July 25 - New Moon

July 28, 29 - Southern Delta Aquarids Meteor Shower. The Delta Aquarids usually produce about 20 meteors per hour at their peak. The shower will peak this year on July 28, but meteors can be visible from July 18 - August 18. The thin crescent moon will set early, leaving a dark sky for observing even the faintest meteors. The radiant point for this shower will be in the constellation of Aquarius. Best viewing is usually to the east after midnight.

August 9 - Full Moon

August 10 - Neptune at Opposition. The blue planet will be at its closest approach to Earth. This is the best time to view Neptune, although it will only appear as a tiny blue dot in all but the most powerful telescopes.

August 12 - Perseids Meteor Shower. The Perseids is one of the best meteor showers to observe, producing up to 60 meteors per hour at their peak. The shower will peak this year on August 12, but you should be able to see some meteors from July 23 - August 22. The nearly-full moon will be a problem this year hiding all but the brightest meteors. The radiant point for this shower will be in the constellation of Perseus. Look to the northeast.

August 23 - New Moon

September 5 - Uranus at Opposition. The blue-green planet will be at its closest approach to Earth. This is the best time to view Neptune, although it will only appear as a tiny blue-green dot in all but the most powerful telescopes.

September 7 - Full Moon

September 7 - Partial Lunar Eclipse. The eclipse will be visible throughout most of Europe, Africa, Asia, and Australia.

September 22 - New Moon

September 22 - Annular Solar Eclipse. The path of annularity will begin off the coast of Brazil and move east and south through the Atlantic Ocean where it will end just off the coast of Antarctica. A partial eclipse will be visible throughout most of South America and western Africa.

September 23 - The Autumnal Equinox occurs in the northern hemisphere at 04:03 UT. There will be equal amounts of day and night. This is also the first day of fall.

October 7 - Full Moon

October 21, 22 - Orionids Meteor Shower. The Orionids is an average shower producing about 20 meteors per hour at their peak. The shower will peak on the 21st, but some meteors can be seen from October 15 - 29. This is a great year for the Orionids. The new moon means the darkest possible sky. Those in dark locations will be able to see even the faintest meteors. Best viewing will be to the east after midnight.

October 22 - New Moon

November 5 - Full Moon

November 8 - Transit of Mercury Across the Sun. This rare event will be fully visible only in the Pacific Ocean regions, but observers in North & South America, Australia, and eastern Asia should be able to see at least a partial transit at sunrise or sunset. The planet will appear as a tiny black moving slowly across the disc of the Sun. The transit will take about 5 hours to complete and will require a telescope with a full-aperture solar filter for viewing.

November 17 - Leonid Meteor Shower. The Leonids is one of the better meteor showers to observe, producing an average of 40 meteors per hour at their peak. The shower itself has a cyclic peak year every 33 years where hundreds of meteors can be seen each hour. The last of these showers occurred in 2001. The shower peaks this year on November 17, but you can see some meteors from November 13 - 20. The nearly-new moon should not be a problem this year for the Leonids. Even the faintest meteors should be visible this year. Look for the shower radiating from the constellation Leo after midnight.

November 20 - New Moon

December 5 - Full Moon

December 14 - Geminids Meteor Shower. Considered by many to be the best meteor shower in the heavens, the Geminids are known for producing up to 60 multicolored meteors per hour at their peak. The peak night this year is December 14. Some meteors should be visible from December 6 - 19. The first quarter moon should set shortly after midnight, leaving a dark sky for observing even the faintest meteors. The radiant point for this shower will be in the constellation of Gemini. Best viewing is usually to the east after midnight.

December 20 - New Moon

December 20 - The Winter Solstice occurs in the northern hemisphere at 00:20 UT. The Sun is at its lowest point in the sky and it will be the shortest day of the year. This is also the first day of winter.

Observing Log

Observer:________________________ **Location:** ______________ **Page:** _______

INDEX	Period - Instrument		Notes
Object	Date	Time	
	Power	Seeing	
	Type Instrument		
Object	Date	Time	
	Power	Seeing	
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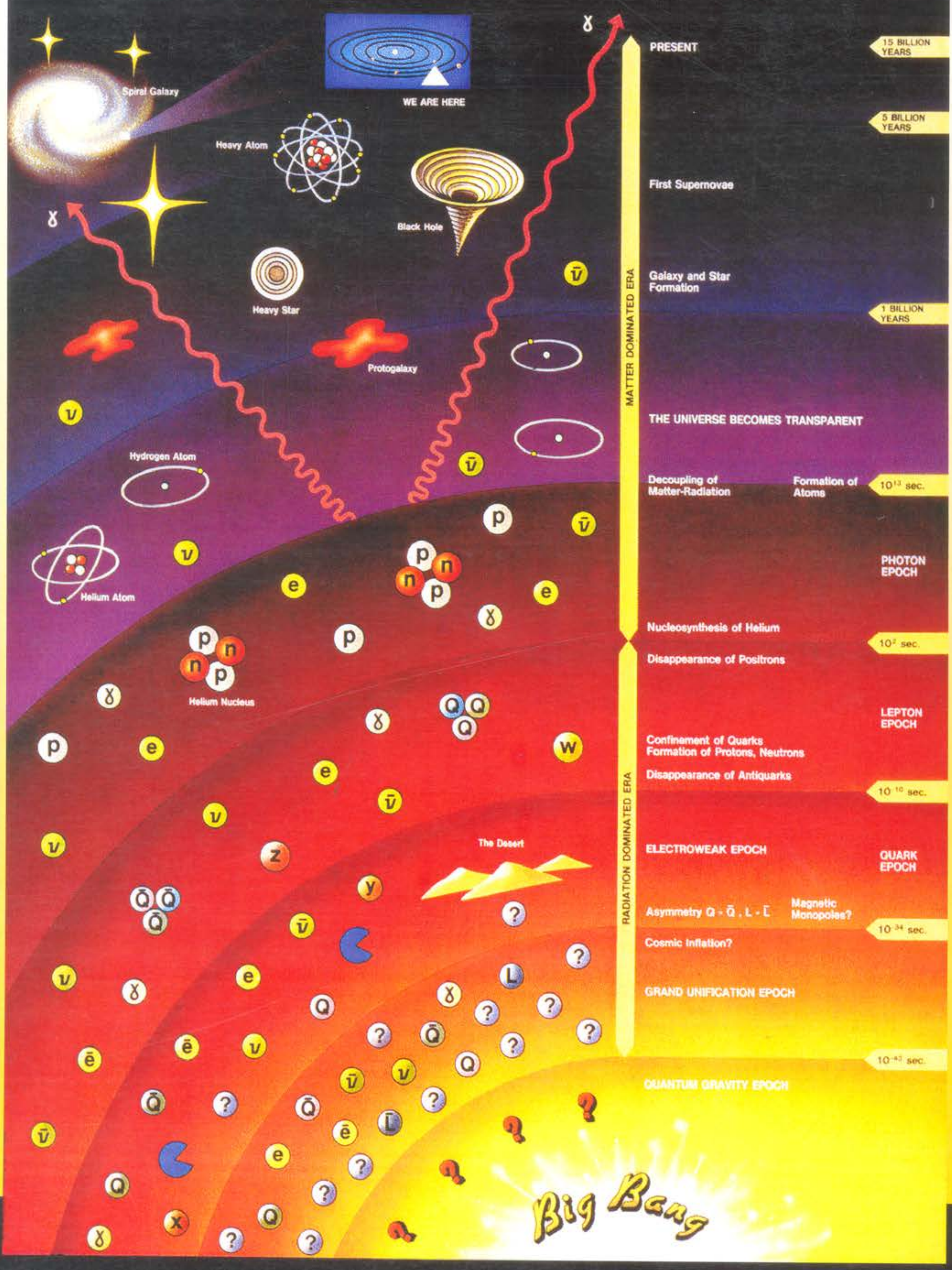
History of the Universe



MATTER DOMINATED ERA

PRESENT — 15 BILLION YEARS

5 BILLION YEARS

First Supernovae

Galaxy and Star Formation

1 BILLION YEARS

THE UNIVERSE BECOMES TRANSPARENT

Decoupling of Matter-Radiation

Formation of Atoms — 10^{13} sec.

PHOTON EPOCH

Nucleosynthesis of Helium

10^{2} sec.

RADIATION DOMINATED ERA

Disappearance of Positrons

LEPTON EPOCH

Confinement of Quarks
Formation of Protons, Neutrons

Disappearance of Antiquarks

10^{-10} sec.

ELECTROWEAK EPOCH

QUARK EPOCH

Asymmetry $Q \neq \bar{Q}$, $L \neq \bar{L}$

Magnetic Monopoles?

10^{-34} sec.

Cosmic Inflation?

GRAND UNIFICATION EPOCH

10^{-43} sec.

QUANTUM GRAVITY EPOCH